Effect of DC input power and nitrogen ratio on the deposition of Ti$_{1-x}$Al$_x$N thin films using high power impulse magnetron sputtering technique

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ABSTRACT

Ti$_{1-x}$Al$_x$N thin films with x varying from 0.72 to 0.86 were deposited using a high power impulse magnetron sputtering (HiPIMS) method in this research. The current-voltage characteristics of the Ti$_{30}$Al$_{70}$ target was first investigated to determine the HiPIMS parameters for film deposition. The microstructure and hardness of the resulting films grown under different target powers and different N$_2$/Ar flux ratios have been studied. It was found that the dual phases of cubic-Ti$_{1-x}$Al$_x$N and wurtzite-AlN co-exist in the resulting films while the grain sizes of wurtzite-AlN are all smaller than that of the cubic-Ti$_{1-x}$Al$_x$N. The deposition rate, ranging from 4 to 9 nm/min, decreases with increasing N$_2$/Ar flux ratio or decreasing target power. N/(Al + Ti) ratio, varying between 0.5 and 1.3, was found to increase with increasing N$_2$/Ar ratio. Films having the highest hardness of 22.3 GPa was obtained when the duty cycle was 3%, the power was 1.8 kW, and the N$_2$/Ar flux ratio was 0.46. The hardness exhibits a strong dependence to the N/(Al + Ti) ratio.

Keywords: High power impulse magnetron sputtering (HiPIMS)、Ti$_{1-x}$Al$_x$N thin films

REFERENCES